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Design For Optimizing Food waste

Maitrayee Sohni
ms8411@rit.edu

RIT College of Art and Design
Industrial Design

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Thesis Title

Maitrayee Sohni

Thesis Author

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The School of Design | Industrial Design
Rochester Institute of Technology | Rochester, New York

Mindy Magyar — Chief Thesis Advisor

Name — Title

Mindy Magyar
Digitally signed by Mindy Magyar
Date: 2020.05.06 12:44:55 -04'00'

Electronic Signature: Use Adobe Acrobat

Alex Lobos — Graduate Director

Name — Title

Alex Lobos
Digitally signed by Alex Lobos
Date: 2020.05.06 09:02:14 -04'00'

Electronic Signature: Use Adobe Acrobat

RIT

Design For Optimizing Food waste

By: Maitrayee Sohni

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Abstract

Having a sustainable food system, which compliments the food production today is a global need. This paper aims to answer what can be done to make the system and products, not just sustainable but how to create a behavioral change towards a sustainable lifestyle and conscious consumption. This paper was initiated to research a solution for food waste in the current system. At the beginning itself, it shows how elaborate the problem is, and needs to be narrowed down. Thus it has been focused on an American household of young adults.

By understanding their behavior, habit, and lifestyle, it leads to the core of the problem. This research work explores how kitchen appliances can be sustainable not just from a materials and manufacturing point of view but from a usability stand as well. The human-centered design process of a product can lead to behavioral changes and thus developing an unconscious habit formation in users. The resulting service and product address the problem of food waste by making the user aware of their food consumption behavior and generating a sustainable lifestyle.

Key words

Food waste, Sustainability, Conscious consumption, Sustainable kitchen design.

Introduction

With new and upcoming technologies and new products being launched daily we come across more sustainable designs. At the same time, we are not living a sustainable lifestyle and it appears more difficult as we come across numerous sustainability myths, material folklore. Sustainability is part of not just production and manufacturing but even user behavior. In a household, the major consumption of energy and materials happens in a kitchen. It is not just renewable resources but perishable food, too count as a major factor towards an unsustainable future.

Food waste is one of the major problems across the globe. Sustainability which appears to be a macro problem seems too difficult to solve and monstrous, but when traced down to its roots it seems to be more practical and solvable. Conscious effort towards small events happening in our day to day life at an individual level can defeat this monstrous problem.

In this paper, we have tried to research the factors which are responsible for food waste by a young adult. They range from shopping, consumption behaviors, (especially the weekly grocery shopping habit that is widespread in many households) food freshness, to food safety issues, One factor which stands common in all these factors is food storage.

The objective of this paper is to propose a solution for the core problem, which addresses not just the environment and produce, but even makes users aware of their consumption pattern. Thus aiming to solve a problem from its roots.

Problem statement

Caught up in their daily schedule and busy lifestyle, young adults who started living on their own in an urban environment become significant contributors in adding up rotten and unused perishable food waste to landfills.

Overview on the problem of food waste

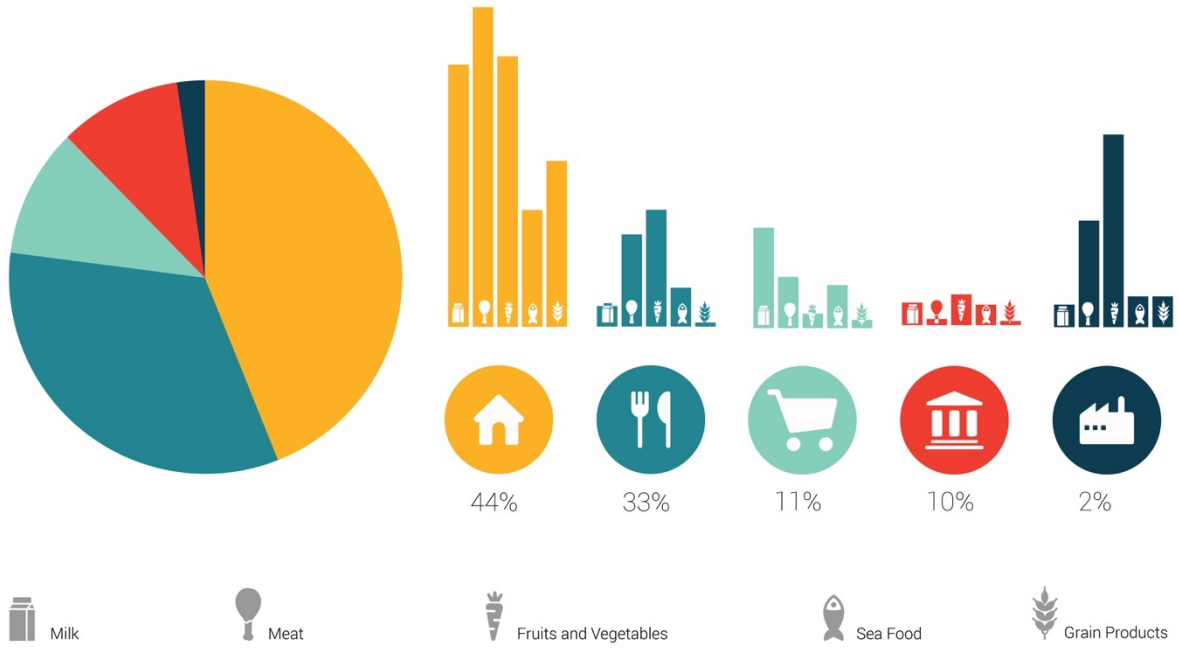

Fig 1: *North American food loss at each step in the supply chain.*

Why is food waste a big problem across the globe?

Europe and North America are not just the Major consumers, they create more then 95- 115 kg of annual food waste per capita, that is one third of the food produced by them. (Marine Masson 2016)1.3 billion tons of food is wasted every year. Household food waste is another major concern in the developed world. Consumers in high-income countries discard up to 30 percent of fruit and vegetable purchases and trim products up to 33 percent by weight during household preparation (Gunders 2012).

The kitchen is the primary yet the unnoticed source of energy. The way we cook and consume our food determines our lifestyle. According to Dorothy Blair's article In Appetite magazine, 25% of energy consumption in the food system takes place in the kitchen. In our kitchen, we not only just create our meals but even food waste and energy waste (Blair 2011). According to the NRDC's issue paper in August 2012, in the United States, 40% of the produced food goes uneaten. Consumer households are the place where most food waste happens. And thus, it needs immediate attention. (Gunders 2012)

Food system

To reach the core problem of food waste one needs to be familiar with the system. System can be subdivided into : Ecosystem, Industrial system and Social system.

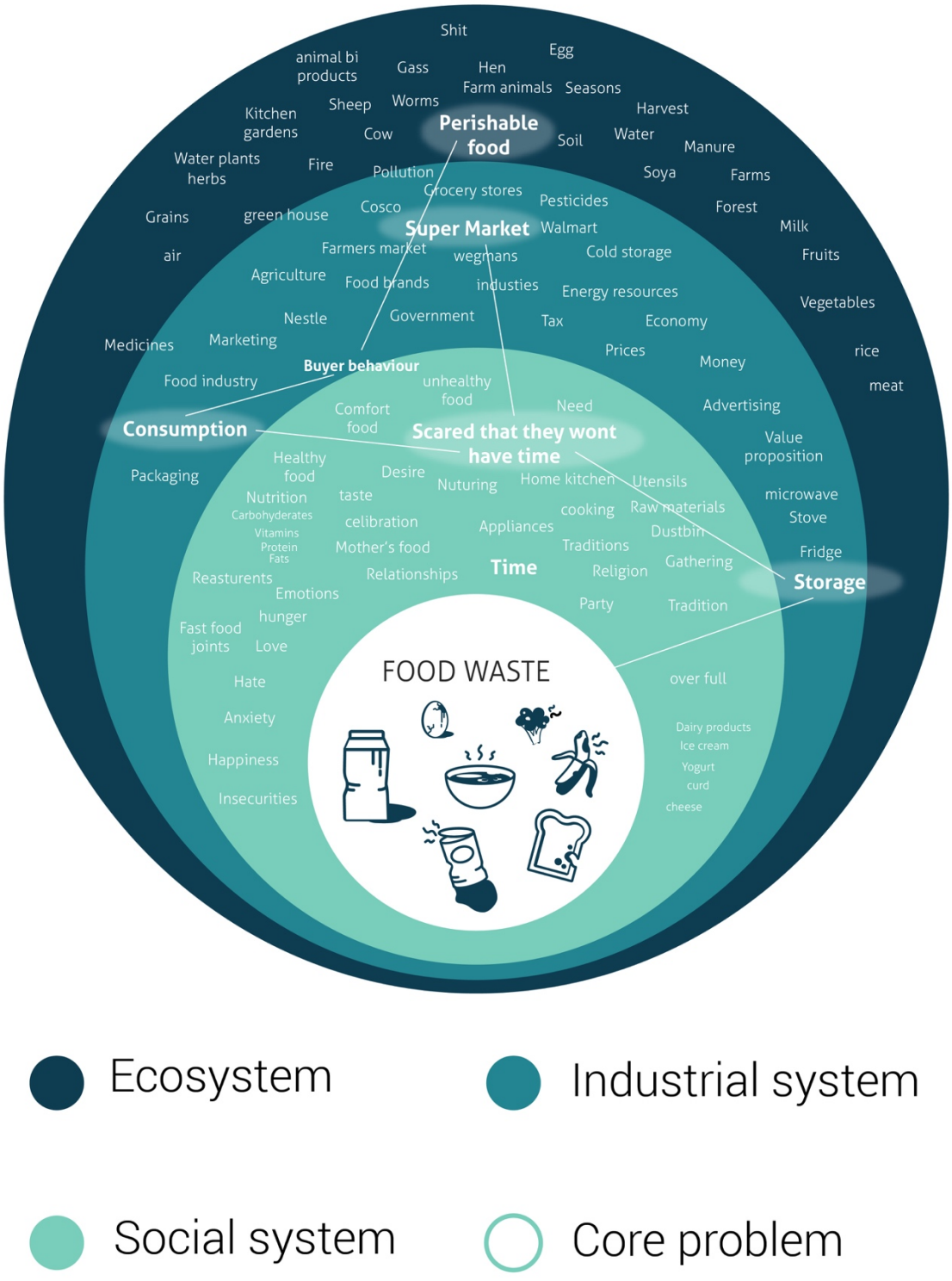

Fig 2: System map

Ecosystem: The source of all the food comes from our planet earth. Before any food is produced its grown , all the basic resources , air, water, soil become part of the system. Even though food is grown for agriculture it later becomes part of the industrial system and eventually part of the social system as well. Looking at the vastness of the ecosystem it's quite difficult to imagine how the problem of food waste is connected.

Industrial system: It is a vast and complex system of industry and government making things accessible to consumers. This system's aim is to make iconomy. Even though it's dependent on the ecosystem its core function is to have all what is needed or more than what is available to users. With coming ages people have become sustainable and industry is trying to bring balance between production and consumption. Consumption is dependent over the social system.

Social System: The mental model of the users, the emotions which are responsible for our actions becomes part of the social system. For example when you get a promotion and you are happy you will go out and celebrate, whereas if you had a break up and are sad, you will order food or take a take out. The way we eat is dependent on our emotions and thus on the social system around us. Thus to understand the root cause of food waste it is essential to be aware of the social system which is causing it.

Food waste at consumer level

The four main types of sustainability are human, social, economic and environmental (Goodland 2002). Even though they are segregated they are interrelated. Food system is a system as complex as any other industry. To understand the problem of food waste we need to understand all its elements. Francesca Zampollo explains what food design is and what are its subcategory. It helps in focusing at different areas of food industry and how we deal with is. She talk about sustainable food design and what we as designer need to keep in mind while we create more. (zampollo 2016)

Dr. Francesca Zampollo's paper on "what is food design" describes all categories of food design in form of a map to clearly visualize all elements of the system. All these define different areas of food design but this helps us clearly visualize different elements in the system:

1. Raw perishable food produce
2. Mass produced food produce, including perishable and non-perishable.
3. Tools, machines, containers and packaging made to cook, contain, serve and transport food at all levels.
4. Food services, all the services related with food, providing, buying-selling, storing, Trashing, growing.
5. Environment in which we have food including home kitchen to restaurant, to cafes to dining hall. It includes all the elements present in the environment.

When we put all these elements down we can clearly see that sustainability is a big umbrella under which we can look at all these elements to reconstruct the system.

Question is, Is food waste really that big of a problem in terms of sustainability?

In this age of the internet, where we are aware of consumption behaviour and worried about global warming global warming and sustainability we even have solutions for it. Waste recycling systems, energy efficient tools

and appliances etc. are there in the market to make us feel better about our habits and consumer lifestyle and yet we are far from a sustainable lifestyle.To achieve a sustainable consumption lifestyle, we need to reflect on our actions and understand our system. While doing my primary research we came across several young adults who live a busy lifestyle with an abundance of food and are guilty of filling up the landfills with tons of unused rotten food waste from their refrigerators. Thus this paper focuses on young adults and their lifestyle to solve the problem of food waste.

It's a major part of our society and thus equally important to social context. To make sustainability a part of our lifestyle I as product designer believe in making it embedded in our daily household activities. To figure out an area in our household I studied a few households and realized the most active part of the house in respect of energy consumption is the kitchen. In 2011 36 million tons of food waste went into United states landfills (Davis and Fisher 2014). The similar research talks about many recycling plants and compost plants which are implemented by the government in many states. I expanded my research even in the field of energy consumption and utensils. Dorthy Blair's article in Appetite magazine explains how choices made by us in cooking food, storage and utensils make a significant amount of energy use.

A paper by National resources defense council of America lists down following as the reasons behind the food waste at consumer level (Dana Gunders 2012):

1. under valuing the food
2. confusion over expiration dates as labelled
3. spoilage
4. improper storage, poor visibility of food in fridge
5. impulse and bulk buying behaviour
6. poor planning
7. access food preparation

A paper on survey on the motivators and barriers of self-reported amounts of food waste in households introduced me to the theory of planned behaviour (framework that aims to explain volitionally controlled behaviour using various constructs) It states the central factor that determines an individual's behaviour is the intention towards the behaviour, that is, the motivation and willingness to act.

1. Someone's attitudes need to be in favour of the behaviour

2. The norms and opinions of other people who are important to the decision maker need to be in favour of the behaviour

3. The individual needs to perceive control over the behaviour

Besides general attitudes towards food waste, three other types of attitudes can be identified from previous studies on consumers' perceptions of food waste: environmental, financial and health concerns. (Luzecka 2014) Consumers eating a healthy diet were found to be motivated to reduce their food waste. On the other hand, consumers who were health-conscious stated that they purchased a variety of perishable foods for their family members, which were not all eaten and thus had to be discarded. Knowledge about the environmental consequences of waste affected people's intention to reduce waste but knowing exactly how much food they discarded or how often, is difficult to keep track of as this behaviour seems rather unimportant in daily life and therefore done without much attention. intention to reduce food waste seems to be the most important predictor of a household's amount of food waste, consumers ought to be motivated to discard less food through their personal attitudes and personal norms, such as strengthening their belief that wasting foods is bad, unnecessary and immoral. how they can determine the correct amount of food to purchase. Although storage knowledge did not appear to have a direct relationship with the amount of food wasted, it is believed that it may have an indirect impact on behaviour through, perceived behavioural control.

Primary User research

Other than the data received from the papers and articles, qualitative data was collected through primary research conducted with 5 users and an online questionnaire filled by 25 people:

1. time spent in kitchen,
2. food wastage,
3. age
4. lifestyle
5. space around them
6. Storage
7. Buying behaviour

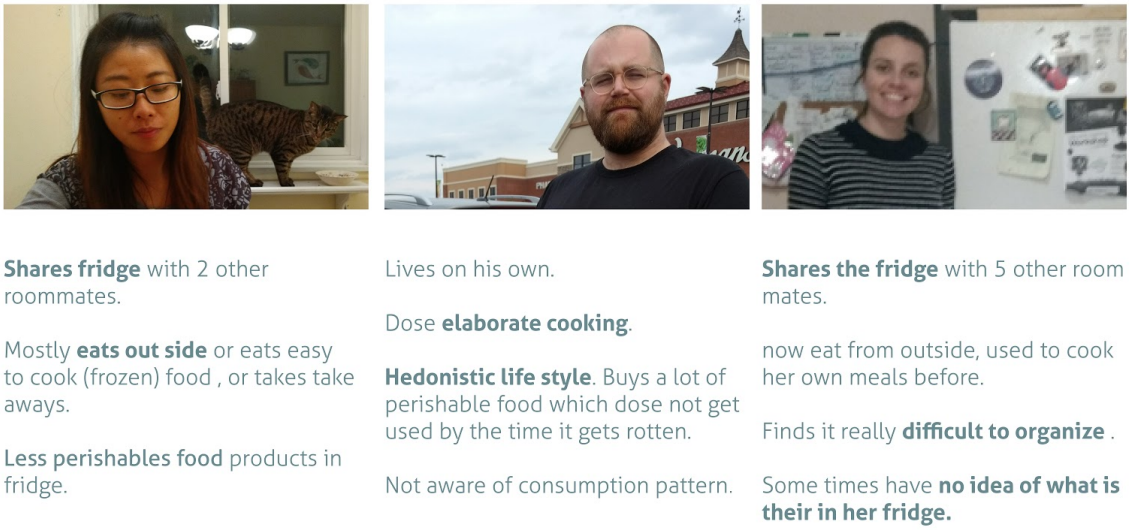

Fig 3: Key Observations

Consumers who are new at living on their own have mixed emotions toward responsibilities seems to go overboard with planning and cooking. Understanding how a kitchen works can be more difficult than it seems. The way a space is designed or the way a user stores food can be of great help.

The most common even in most of the surveys was a mysterious and cluttered fridge. Many people thought they knew what they had but were surprised to find few items when explored deeper in their fridge. The Images below show some of the problem areas which surfaced during this phase:

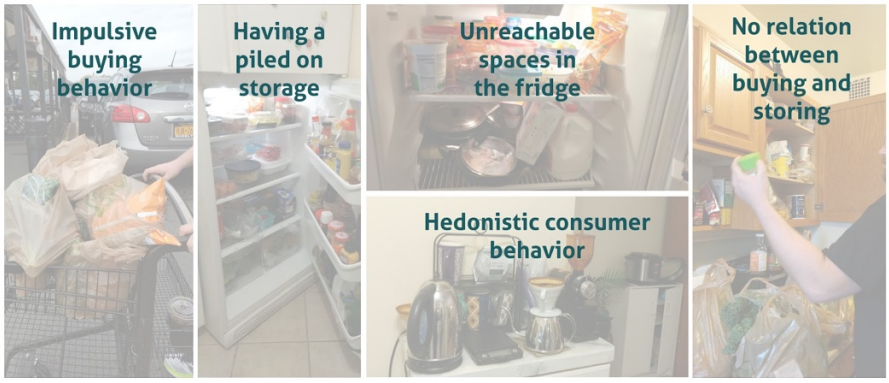

Fig 4: Core problems

1. **Impulsive Buying behavior:** On a grocery day, the subject went and did shopping without any plan but more on what they saw and kindled their instincts.
2. **Having a piled on storage:** Once their groceries reach their second destination, refrigerator or kitchen pantry, storage spaces are visually stocked up and seem difficult to find a place for new groceries.
3. **Unreachable spaces in the fridge:** In the process of trying to stock up new groceries, some old forgotten food items are discovered.
4. **Hedonistic Consumer behavior:** Subject had products that were more of want or desire rather than needs.
5. **No relation between buying and storing:** Many of the products which the subject bought were already there at home.

With qualitative and quantitative data received, it is time to analyze users' habits and behavior in the current system.

User and system analysis

Trying to understand consumer's habits based on a small survey seemed kind of unfair. Thus all the observations made from the research was plotted into a mind map:

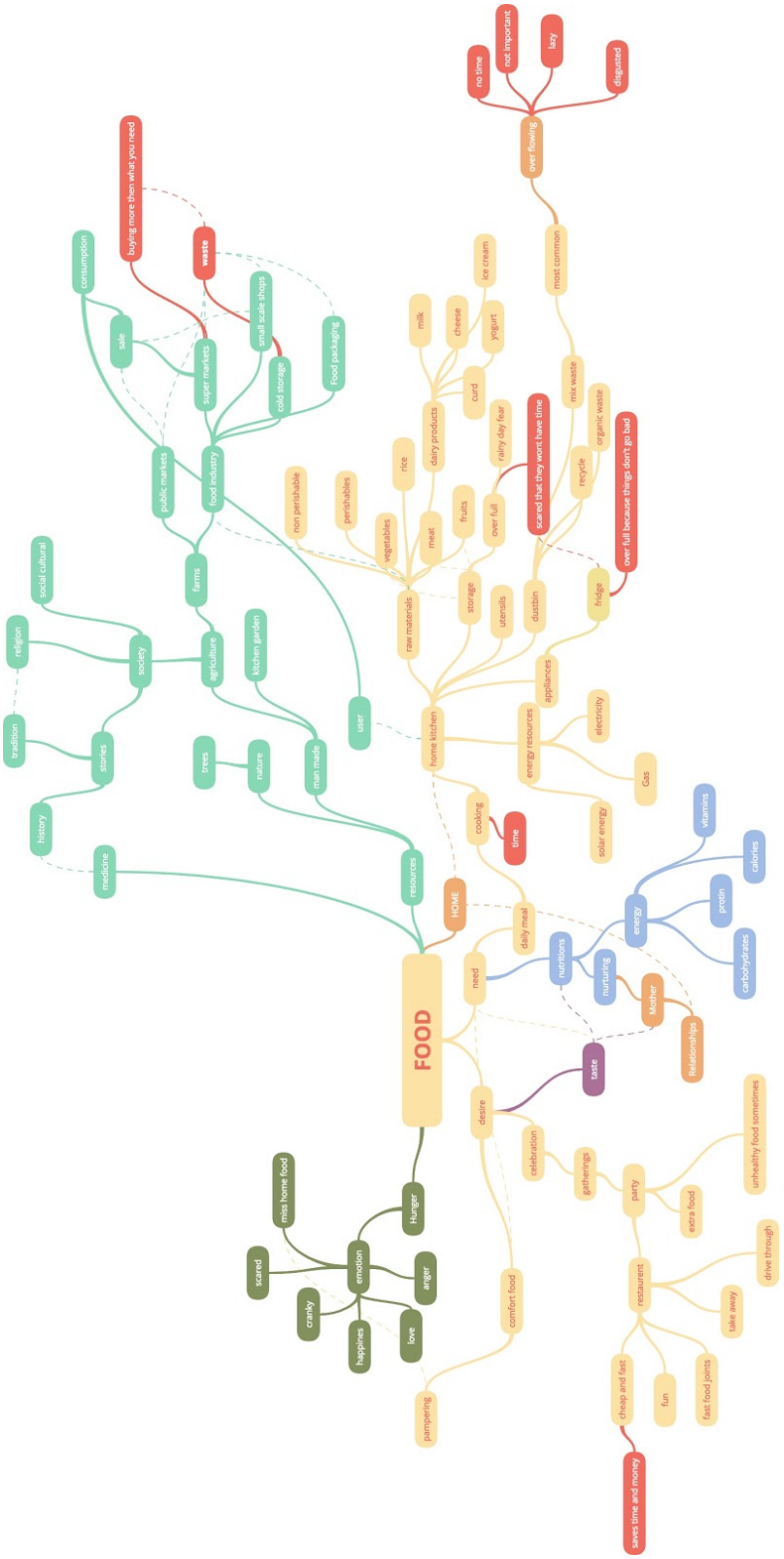

Fig 5: Mind map

Mind Map helps in separating cause and effect elements. To analyse the main reason behind the cause I used Iceberg module that is :

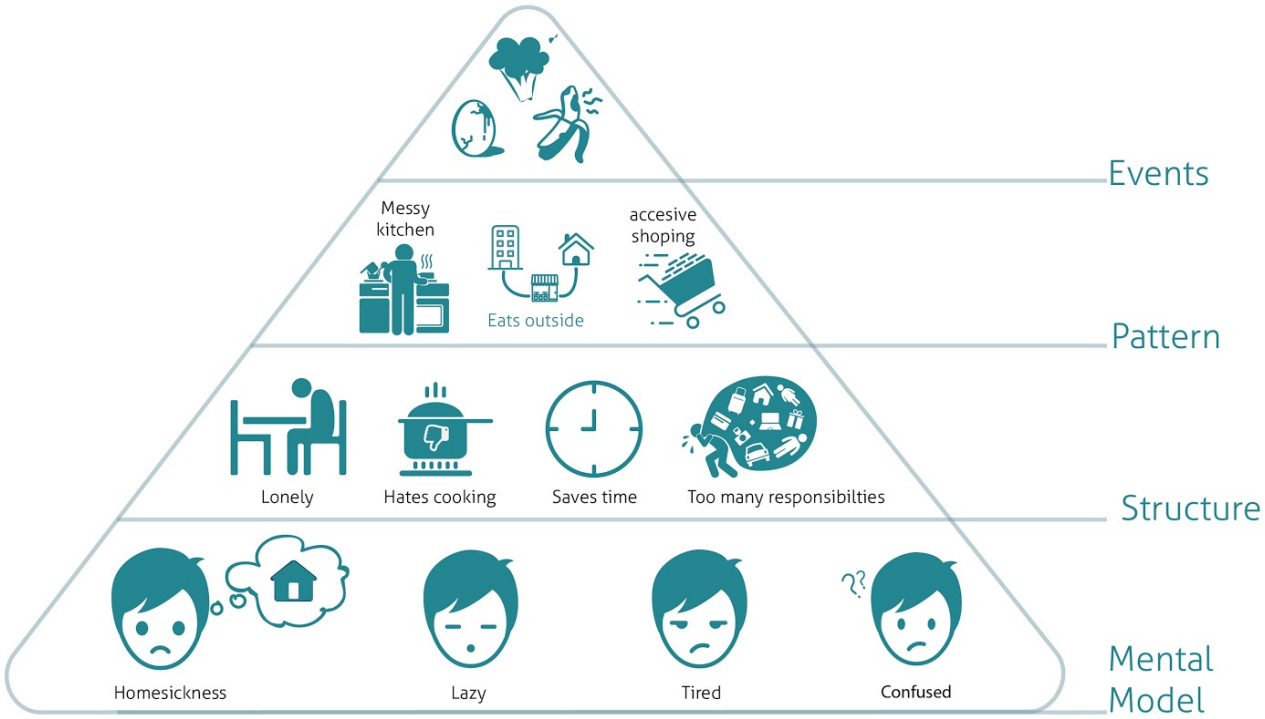

Fig 6: Iceberg module

Food waste, as it's rotten or expired because it's forgotten.

Pattern:

Patterns which happen quite frequently leading to the event. In this scenario, having a messy kitchen, Take outs or eating outside even when there is perishable food at home, buying more than one need are common patterns.

Structure:

Reasons which lead towards Patterns, In this case loneliness, no motivation to cook, Burdened with responsibilities.

Mental Model:

Users State of mind which leads to structure. Homesickness, feeling confused.

With this we realized as some consumers who are new at living on their own have mixed emotions toward responsibilities. These young adults seem to go overboard with planning and cooking. Understanding how a kitchen works can be more difficult than it seems. The way if they are guided on what to cook, how much to

buy, space is designed to store food the right way can be of great help. The most common event in most of the surveys was a mysterious and cluttered fridge. Many people thought they knew what they had but were surprised to find few items when explored deeper in their fridge.

Thus, the direction towards , assistive buying, redesigning the fridge interior for perishable food products, improving their storage knowledge is a key towards an indirect impact on users behaviour, **perceived behavioural control.**

Benchmarking

What other things are there in the market to solve the same problem?

1. **Refrigerator**
   In a home refrigerator is a primary place for storing produce. The statistic shows the number of households that used a refrigerator in the United States as of 2015 amounted to 118.2 million, of which 35.1 million used two refrigerators or more and yet we have food waste, As technology are evolving we have bigger and smarter refrigerators but the amount of food waste is not going down (Marine Masson, An observational study of refrigerator food storage by consumers in controlled conditions 2016). Today the Family Hub refrigerator by Samsung allows users to look inside their fridge through a camera. The Cost of this refrigerator is not something a Young adult can afford. At the same time the way people arrange their refrigerators is more cluttered to get a clear image of all the things stored in one refrigerator.
   The crispy drawers are designed to keep our produce fresh, but that is when vegetables are stored properly with a breathing space for certain days. But with the vegetables kept in it, out of sight and forgotten for weeks they are prone to go bad. Thus how advanced the technology can be if it's not used the way it is intended to we will have food waste.

2. **FridgeCam**
   In 2019 a UK based company Smarter launched FridgeCam. For those who can not afford a smart refrigerator it gives you similar features for 49 euros. It aims to reduce food waste by tracking the expiry dates of your perishable foods so that you can plan your meals around what's about to expire.

3. **Ethylene absorbers**
   One of the most common ethylene absorbers in the market for commercial use Blueapple. It is a blue, apple-shaped product that sits in your refrigerator and absorbs ethylene gas, allowing consumers to store fresh produce for longer. It lasts for three months before it needs a refill, and is capable of extending produce shelf life by up to three times.

4. **Produce saver containers**

Rubbermaid is a well known brand known for its airtight containers. They have made Freshworks produce containers, which makes your produce last longer because of a crisping tray in the bottom that keeps moisture away.

5. **Breathable produce bags**
   There are many cotton breathable bags available to store produce .While crispy drawers fasten ripening by trapping stale air and ethylene gas, a damp cotton bag keeps vegetables alive and crisp in a high humidity, breathable environment.

Some services help reduce food waste:

1. **Olio**
   Many times we may have an eggplant in our fridge for which we have no time to cook and will end up rotten in the trash by weekend whereas our neighbour might be planning to do a grocery run just to make an egg plant parmesan. Olio is a free app that connects neighbors with each other to flag up and share surplus food. Users just upload a photo and description, then people in the neighborhood can claim the food before it's wasted. Thus reducing food's journey to the trash bin and making a huge impact.

2. **Meal Kits**
   Hello Fresh and Blue Apron are just the two of the many meal kits available now. Other than their cost they seem to be perfect for a young adult to reduce food waste. Completely customizable as per dietary restrictions, it delivers all the raw ingredients at your door steps. With a guided recipe to make delicious meals. They pack food in a ropotion so that there is no waste by the end of it. It does help users from pressure of planning and excessive grocery runs. Freshly is another one of them which provides healthy precooked meals, thus even saves time. The only drawback is the cost.

Proposed direction

The final Goal is to have young adults living in an urban environment with limited financial budget, waste less food. Through the research 3 reasons which are the major cause of food waste came up front.

1. Time: priority given to the activities decides and the time we give to them are directly proportional to each other. Having a stressful schedule, grumbling stomach, craving for delicious food, option of the tack out and frozen food supplies cooking is given the least priority.

2. Buying: At the same time the aspiration of eating healthy and control over their life makes them plan their week ahead and buy a week or couple of week full of supplies of perishable food products. Lack of knowledge about the life span of the food while buying in correlation with the eating pattern is another reason of perishable food waste.

   (Marine Masson, An observational study of refrigerator food storage by consumers in controlled conditions 2016) (Marine Masson, An observational study of refrigerator food storage by consumers in

controlled conditions 2016) (Marine Masson, An observational study of refrigerator food storage by consumers in controlled conditions 2016)

3. Storage: Midpoint between Buying and cooking or throwing is storing. At times user forget what they have stored. Having expected to have food remain fresh while stored user tend to ignore cooking because of less time. The way we organise our storage system didn't tell us what all food we have and tend to create hidden spots in our refrigerator. Connecting the point of buying to cooking storage space comes as a midpoint of the problem.

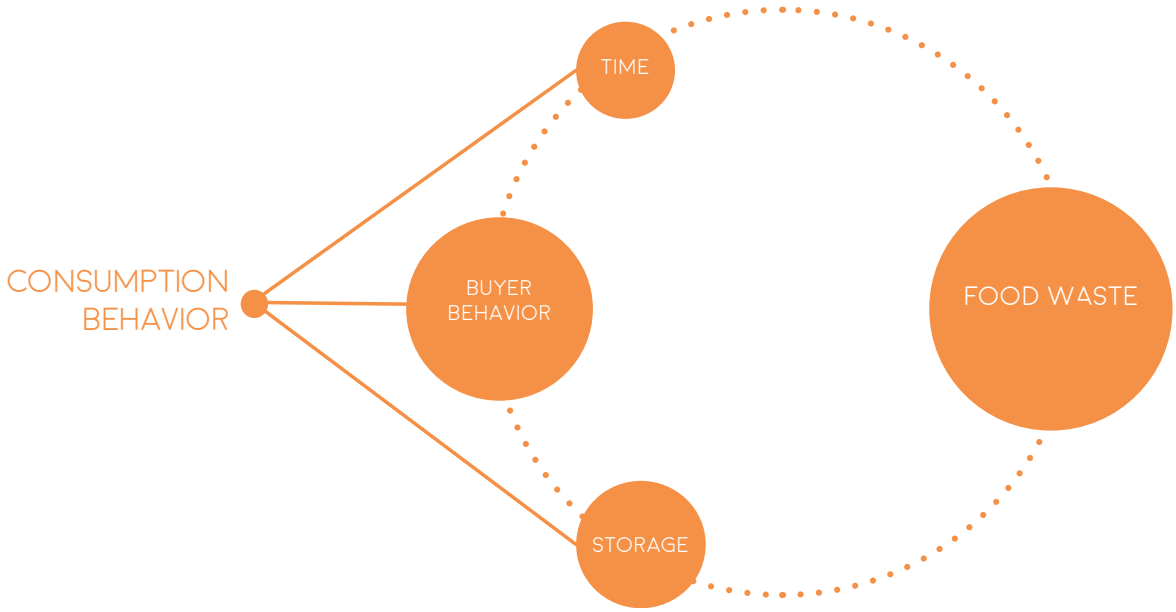

Fig 7: Direction map

To optimize food waste a user must be aware of their consumption pattern and that can be achieved only when they understand the relation between storing, buying and cooking. Young adults who begin living on their own have mixed emotions toward responsibilities tend to go overboard with planning and cooking. Survey shows that 96 % of the users have cluttered their fridge about which they don't have any clue now. A storage space (refrigerator) should be designed such that it gives user a visual feedback, and that can in following ways:

1. By changing the visual hierarchy.
2. By not having hidden corners.
3. Having interrelated storage containers.

Design rationale

The modular perishable food organizer is a medium for user to:

1. Planning their meal and ordering groceries thus connects the experience of shopping with consuming.
2. Organizing vegetables and meat in their refrigerator so that they don't have a reduced life because of improper storage.

3. Have a visual hierarchy in their refrigerator, so that users don't forget about produce after buying.

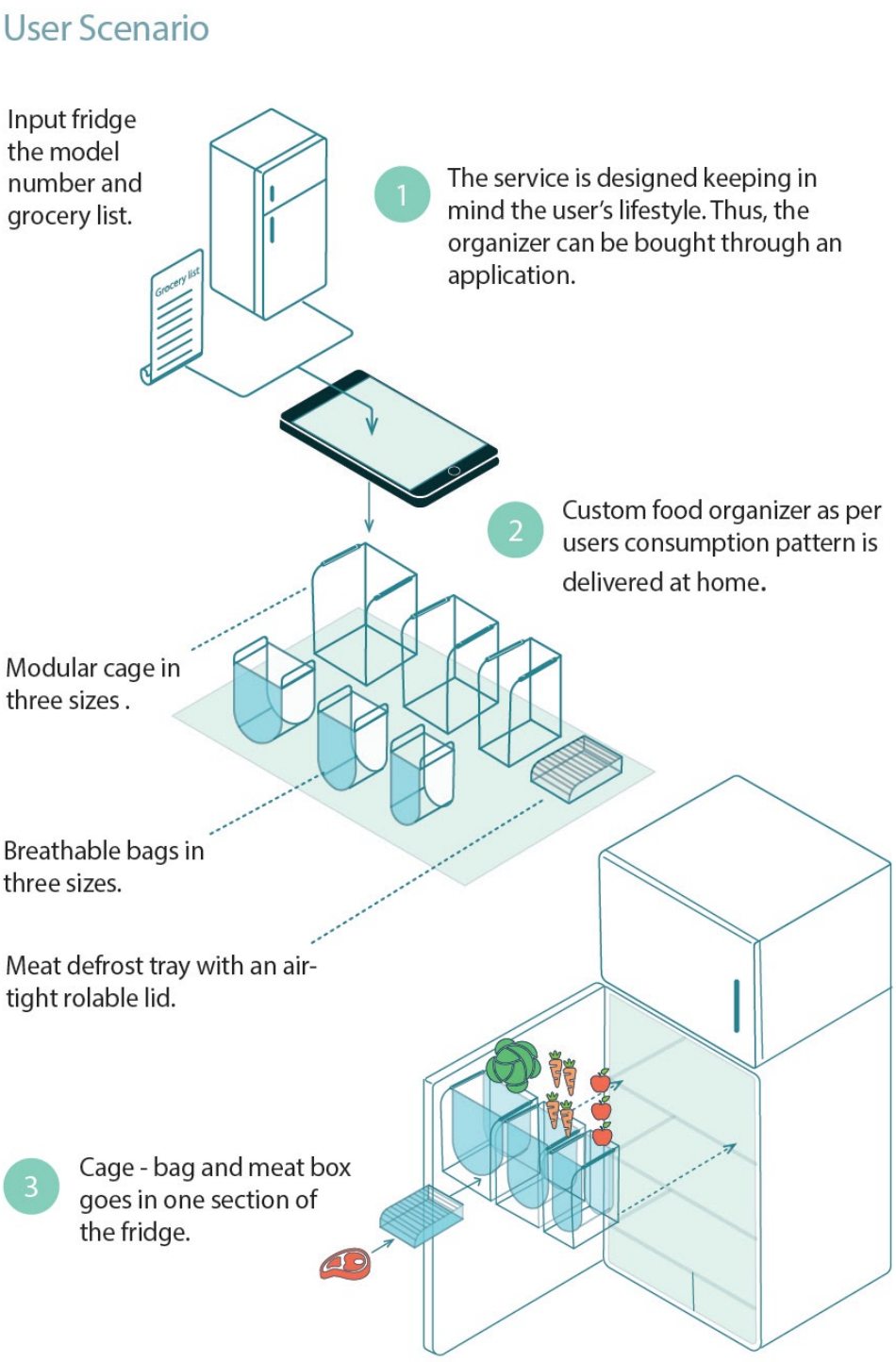

Fig 6: Proposed solution

The materials which will be used to create food organizer are based on the food soring research.

A breathable bag made of cotton spandex net cloth, whose size is dependent on the consumption pattern.

These bags will be hung on the modular rig structure which will be provided to users according to their fridge model. This keeps veggies fresh by letting Ethelyn escape.

Conclusion

To ensure sustainable production and consumption of food across the globe is a big challenge and is a responsibility of not just Farmers and Food suppliers but of consumers as well. If the system is designed to ensure conscious consumption and by aiding users to have a healthy lifestyle then we come more closer towards achieving a sustainable future. Designing the buying experience is dependent on several other factors: product information, their enjoyment due to shopping, price criteria, and the use of a shopping list. Design of the cooking experience is dependent on how purchased items are converted into meals, such as how much time is used for the preparation of a meal (Austin Rong-Da Lianga 2011).

A home appliance is sustainable not just if it consumes energy, production method and material are Eco friendly but if it sustains or elongates the life of other elements in the same system. Usability is also one of the main criteria while designing for sustainability. User product interaction and connection increases or decreases its lifespan. A product can perceive a user to change habits or make them aware of their consumption pattern. We need companies to keep usability towards a conscious consumption as a key component while making a products to sustain our future.

Bibliography

Gunders, Dana. 2012. "Wasted: How America Is Losing Up to 40 Percent of Its Food from Farm to Fork to Landfill." *Natural Resources Defense Council* (iP:12-06-B): 4-6.

DorothyBlair. 2011. "Sustainability in the kitchen. Reconsidering the way we cook and store food." *Appetite* 56 (2): 521.

Blair, Dorthy. 2011. "ustainability in the kitchen. Reconsidering the way we cook and store food." *Appetite* 521.

Marine Masson, Julien Delarue, David Blumenthal. 2016. "An observational study of refrigerator food storage by consumers in controlled conditions." *Food Quality and Preference* 1.

zampollo, francesca. 2016. *Food design with francesca zampollo.* November 23. Accessed September 20, 2017. http://francesca-zampollo.com/food-design/.

Davis, Amanda, and Robin Fisher. 2014. *Kitchen and Bath Sustainable Design : Conservation, Materials, Practices.* Hoboken: John Wiley & Sons, Incorporated.

Dana Gunders, Natural Resources Defense Council. 2012. "Wasted: How America Is Losing Up to 40 Percent of Its Food from Farm to Fork to Landfill." *NRDC* 23.

Luzecka, Tom Quested and Paulina. 2014. *Household food and drink waste: A people focus.* WRAP.

Marine Masson, Julien Delarue, David Blumenthal. 2016. "An observational study of refrigerator food storage by consumers in controlled conditions." *Food Quality and Preference.*

Goodland, Robert. 2002. "Sustainability: Human, Social, Economic and Environmental." *Encyclopedia of Global Environmental Change.*

Austin Rong-Da Lianga, Wai Mun Limb. 2011. "Exploring the online buying behavior of specialty food shoppers." *International Journal of Hospitality Management* 857.

Vermeir, Iris, and verbeke Wim. 2008. "Sustainable food consumption among young adults in Belgium: Theory of planned behaviour and the role of confidence and values Author links open overlay panel." *Ecological Economics* 64 (3): 542-553.

Tull, Deborah Eden. n.d. *The natural kitchen. your guid to the sustianable food revolution.* Port town send, WA: Process Media.

2016. *Minimalism: A Documentary About the Important Things.* Directed by Matt D'Avella. Produced by Matt D'Avella, Joshua Fields Millburn Ryan Nicodemus. Performed by Sam Harris, Dan Harris, Jeff Sarris Ryan Nicodemus.